men of science. In particular they may expect sympathy from the astronomical world, which will soon be faced by an allied problem. The question must, before many years, come up for decision as to when a repetition of the chart of the heavens, which is slowly nearing completion, will be justified by the conclusions to be drawn from it.

SCIENTIFIC STUDIES OF DEW-PONDS.

AN endeavour to solve the so-called mystery of the dew-pond has recently been made by Mr. E. A. Martin, and the results of some of his observations are shown in a paper which appears in the *Geographical Journal* for August. The paper was read before the Research Department of the Royal Geographical Society on April 22. Attempts were made by direct experiment to ascertain how the replenishment of such ponds takes place. During the autumn of 1908, Mr. Martin spent many nights and days on the Clayton downs, in Sussex, and thus was on the spot during the hours when, according to theory, the ponds should be receiving dew. The result of a large number of thermometrical observations went to show that very rarely does the temperature of the water of the ponds sink below that of the air above it, or below dew-point.

The term "dew" is widely used to mean any kind of condensation which does not fall as rain, hence "dew-ponds," "mist-ponds," and "cloud-ponds" are terms which are used for one and the same kind of pond. On the Sussex Downs no overhanging tree to condense moisture out of the air is found, as a rule. The bare down is all around, whilst in the water there is, as a rule, pond-weed, or reeds, sometimes projecting above the surface of the water. Where this happens, dew is undoubtedly precipitated on the reeds, and this helps to replenish the pond. But many ponds have no projecting vegetation, and yet do not suffer greatly in times of drought. It is pointed out that the measurements of some ponds and their surrounding basins give a receiving area sometimes double the area of the water. In one case the pond-area was 4120 square feet, whereas the shelving margin gave an area of 5795 square feet. Other similar examples are given, and it is this width of margin which has caused many observers to conclude that rainfall is the chief factor in filling the ponds; but not the only factor, as Mr. Martin points out, otherwise there would be little reason why the lowland ponds should dry up in times of drought, and leave the upland ponds fairly full.

Thermometrical observations show that the depth of a pond at the commencement of a drought has much to do with its continuance. A shallow pond was found rapidly to dry up by evaporation, the high temperature gained during the day being well maintained during the night. On the other hand, a deep pond will but slowly be heated, and may well be saved excessive evaporation until a break in the weather comes, and normal conditions again prevail. One pond which was but a foot deep was found so late as 8.20 p.m. in July to show no differences of temperature at 1 inch, 6 inches, and 9 inches, the thermometer registering 67·5° F., whilst that on the bank showed a reduction to 58·5° F. The water lost heat but slowly, and no doubt evaporation went on well into the night. Three weeks later it was dry. Another pond, 3 feet deep, showed, at 6 p.m., 76° F. at 1 inch, 74° F. at 6 inches, and 71° F. at 9 inches, and two hours later the 1-inch temperature had been reduced to $70\frac{3}{4}$° F., whilst the 6-inch and 9-inch temperatures were uniform at 71° F., the surface temperature showing a considerable loss. There was in this pond a large quantity of rushes, and the loss by evaporation was almost compensated for by the deposition of dew upon their exposed surfaces. This pond did not dry up.

Attention was given to the alleged chilling of the water below dew-point, but it was found that although such a circumstance rarely happened, it sometimes was seen that the temperature of the air resting on the water was below dew-point. Further observations in this direction are to be made. Numerous experiments were made to determine whether straw, wood, and woodwool were likely to effect a chilling of the water of a pond resting on a foundation of these materials, and the evidence pointed to these acting in the desired direction. A series of experiments showed that both "downward" and "upward" dew would be found on different nights according to certain atmospheric conditions, and it is pointed out that if a pond were to depend on the latter only for its replenishment, it would simply receive what it had previously lost by evaporation. The chilling effect of grass on the moisture-sodden lowest stratum of the atmosphere results in dew on the grass, but there is no such chilling of the air by the pond-water, and if dew is there deposited there must be some other cause at work.

It is found that out of seven localities quoted where straw has been used in the foundations of dew-ponds, in no case has it been used with the idea of inducing dew-deposition in the pond. Sections of dew-ponds are given in the paper, constructed according to various authorities. The most remarkable case seems to be that in Wiltshire, where foundations are laid in the form of six layers of straw and clay alternately, but here again the reason given is that the straw prevents the clay from cracking. Incidentally, Mr. Martin refers to the danger to clay-puddled ponds from the small red-worm, swarms of which were met with in some ponds. An estimate of dew-fall on grass was made, giving 0·77376 inch per annum.

So far as rainfall is concerned, it was found that in thirty-two days the amount measured on the downland was 2·57 inches, but a gauge placed in a hollow dug for an experimental pond measured 3·51 inches. This seems to show that a pond-depression on the downs would draw into it, by setting up currents and eddies of the wind, a greater quantity of rainfall. By experimenting with a gauge in the rim of which had been placed some straw and grass, in imitation of conditions which obtain in some ponds, it was found that when 0·37 inch was measured on the down, 0·54 inch was measured in the gauge; when the former showed 0·32 inch, the latter showed 0·69; when the former showed 0·46 inch, the latter showed 0·80 inch. The gauge with the straw and grass was placed in the hollow.

In order to determine whether the chemical composition of pond-waters would give any clue to their origin, a number of analyses of such waters was made at the South-Western Polytechnic, and the results are given in the paper. These seem to show that there is too much sodium chloride contained in the ponds to have come from rain-water, and in normal conditions dew certainly contains no common salt. The sea-mists may reasonably be held to be responsible for the saline qualities of the waters.

So far as the antiquity of the name and the idea of the dew-pond is concerned, Mr. Martin seems to think that puddling by cattle-trampling by accident may have caused artificial ponds first to have been made, and although proof must be lacking, it is possible that

some may be of very ancient date. Wells are so rare in ancient camps on the downs that ponds were probably the chief source of water supply. Why straw was first used, and how it was first used, are likely to remain unanswered satisfactorily. A description is given of a small experimental pond which the author made. The foundations were composed of wood-wool resting on a chalk base, followed by straw and wooden planks, with puddled clay thereon. Further investigations are promised, and no doubt the success or otherwise of the pond will form the subject of a future paper.

In the discussion which followed the reading of the paper, Dr. H. R. Mill claimed that rain is the principal factor in filling the downland ponds, and suggested that the reason why the lowland ponds the more quickly dry up may be that they are not so carefully made watertight as those on the higher ground.

ARTIFICIAL PARTHENOGENESIS.[1]

THE development of biology into an experimental science is nowhere better illustrated than in the important researches on artificial parthenogenesis which we owe largely to Jacques Loeb, and biologists will welcome heartily the little book in which this distinguished author gives an account of the subject. Prof. Loeb informs us that the object of his investigations was to transfer the problem of the fertilisation (Entwicklungserregung) of the animal egg from the domain of morphology to that of physical chemistry. He recalls the fact that it is only about sixty years since it was first firmly established that the animal egg—with the exception of a few cases—can only develop into an embryo after fertilisation by the entrance of a spermatozoon. Various interpretations have been placed upon this process. O. Hertwig maintained that the essential feature of fertilisation was the union of the male and female pronuclei in the egg-cell, and the observation of this union was undoubtedly of the greatest importance, especially from the point of view of the theory of heredity, but it gave us no real insight into the nature of the stimulus which evokes as its response the segmentation of the egg. Boveri, indeed, maintained that the union of the two pronuclei had nothing to do with providing this stimulus, and was able to show that an enucleated egg may develop after fertilisation by a spermatozoon. According to Boveri the centrosome is the organ of cell-division, and the unfertilised egg cannot develop because the centrosome is wanting. A new centrosome is introduced by the spermatozoon, and then cell-division or segmentation commences.

Loeb, however, maintains that the development of the egg is a chemical process, depending mainly on oxidation, in which there takes place a synthesis of nuclear material from constituents of the cytoplasm. He accordingly regards the Boverian hypothesis, in which a purely mechanical *rôle* is assigned to the centrosome, as inadequate to explain the nature of fertilisation. His earliest experiments consisted in treating the eggs of a sea-urchin with sea-water, the alkalinity of which had been increased by the addition of soda-lye. In such water the eggs segmented once or twice, but did not develop further. On the other hand it was found possible to cause the unfertilised eggs to develop into larvæ by placing them for a couple of hours in hypertonic sea-water—sea-water, that is, the osmotic pressure of which had been raised about 60 per cent. by the addition of some kind of salt or sugar. This apparently purely osmotic stimulation of the egg was subsequently found to comprise two factors, viz., the loss of water by the egg, and the concentration of the hydroxyl-ions of the hypertonic solution. It was also found that the hypertonic solution can only stimulate the egg to development if it contains free oxygen in sufficient quantity.

The author next succeeded in producing larvæ from unfertilised eggs of Chætopterus by means of potash and acids without raising the osmotic pressure of the sea-water.

It has long been known that the eggs of many animals, immediately after the entrance of the spermatozoon, form a "fertilisation membrane" on the surface. We used to be told that this membrane served to prevent the entrance of additional spermatozoa. Loeb attributes to it a much deeper significance. He finds that in the case of osmotically "fertilised" eggs no membrane-formation takes place, but a short treatment with a monobasic fatty acid causes the formation of a typical "fertilisation-membrane" in all the eggs of Strongylocentrotus. If such eggs are then placed for a short time in hypertonic sea-water they all develop into larvæ. The artificial membrane-formation by itself, however, in this case only causes the eggs to commence their development without being able to continue it.

The membrane-formation is regarded as the most important factor in fertilisation. It has also, however, a deleterious effect, a tendency to cytolysis, which requires to be counteracted by treatment with a hypertonic solution, or in some other way. In some species the artificial membrane-formation alone is sufficient to bring about the development of the eggs to normal larvæ, the injurious cytolytic effects being less marked than in the sea-urchin. That it is the membrane-formation and not any other action of the fatty acid which brings about the development of the egg is evident from the fact that membranes produced in any other way have the same effect.

The author attributes a like importance to membrane-formation as the essential factor in the normal fertilisation of the egg by the spermatozoon, and proceeds to inquire what substances and agencies determine such formation. Membrane-formation may be regarded as a stage in the cytolysis of the egg, and all cytolytic agents will cause membrane-formation. Clearly the cytolysis must be arrested in some way after the membrane has been formed, otherwise it will lead to the destruction of the egg. Loeb maintains that in the natural fertilisation of the egg the formation of the fertilisation membrane is brought about by a "lysin," carried by the spermatozoon, which also brings with it a second substance which serves to counteract the evil effects of membrane-formation.

Such is the essence of the "Lysin Theory" of fertilisation. As an attempt to interpret biological phenomena in terms of chemistry and physics, it is of the greatest interest, though the point of view from which its author regards the phenomena of fertilisation may not be the one which appeals most strongly to students of biology.

We do not doubt that a new edition of this extremely interesting work will shortly be called for, and we hope that it may be found possible to publish it simultaneously in German and English. Not the least valuable feature of the book is, to our mind, the introduction of twenty-one pages, in which a concise *résumé* of the entire subject is given.

[1] "Die chemische Entwicklungserregung des tierischen Eies (Künstliche Parthenogenese)." By Jacques Loeb. (Berlin: Julius Springer, 1909.) Price 9 marks.